Comox Valley REGIONAL DISTRICT

Staff Report

DATE: May 6, 2020

FILE: 5340-20

TO: Chair and Members
Comox Valley Sewage Commission

FROM: Russell Dyson
Chief Administrative Officer

Supported by Russell Dyson
Chief Administrative Officer

R. Dyson

RE: Update on Odour Control Upgrades

Purpose
To provide an update on engineering and construction of the odour control upgrades at the Comox Valley Water Pollution Control Centre (CVWPCC).

Recommendation from the Chief Administrative Officer:
THAT the scope of the odour control upgrades be revised from Option 2B per the approved recommendation at the February 11, 2020 Sewage Commission meeting, to Option 2C based on the rationale provided within this staff report dated April 23, 2020.

AND THAT the Comox Valley Regional District proceed with engineering and construction of odour control upgrades at the Comox Valley Water Pollution Control Center that include covering of bioreactors and installation of a new wet chemical scrubber, estimated at $6.5 million.

Executive Summary
At the February 11, 2020 Comox Valley Sewage Commission meeting, upgrades to improve odour emissions from the CVWPCC were approved. Completion of upgrades by summer of 2021 is a priority and the project is proceeding despite the current pandemic. The below bullets provide an update on project status:

- Procurement of a detail design consultant (complete): Detailed design was direct awarded to ISL Engineering and Land Services. Direct award was chosen to allow staff to maintain the aggressive schedule, through avoiding a lengthy competitive procurement process and drawing on ISL's previous odour control work at the CVWPCC.
- Development of a project and procurement strategy (complete): The chemical scrubber and bioreactor covers have significant lead times and are the critical path items for completion of the project by summer 2021. To mitigate schedule risks due to the lead times, procurement of these items will be completed ahead of the invitation to tender for construction, therefore equipment will be on site and ready to be installed following selection of a contractor.
- Project scoping (complete): Attached, for reference, as Appendix A to this report is the Odour Control Options Cost report completed by ISL in January 2020 and presented at the February 11, 2020 sewage commission. Since completion of the options analysis and presentation of the staff report in February, a comprehensive review of future upgrade timing and air flows has been completed. This review has led to the recommendation to twin the existing scrubber with a new, smaller one, (Option 2C within the ISL report,

with a refined capacity of 40,000 m^3/h) rather than replace the existing scrubber with a new larger one (Option 2B within the ISL report, capacity of 80,000 m^3/h).

Further the optimization of project scope, internal analysis and due diligence completed since February has concluded that:

- Option 2C will provide better odour performance, and a higher certainty of delivering the projected odour reductions, as it will continue to treat the most odorous gases with both a chemical scrubber and carbon polisher, and only treat the much less odorous bioreactor gas with just a chemical scrubber. The estimated performance of this option was confirmed by RWDI in their February 5, 2020 report (RWDI option 2a).
- The Class 'D' cost estimate for Option 2C is $6.5 million, approximately $0.5 million less than the previously approved Option 2B. While this option will include an additional future cost to replace the existing scrubber (which will remain in service for Option 2C), this future cost is likely to be mostly offset by the benefits of using the existing scrubber until the end of its lifespan. The shift from Option 2B to 2C is not expected to significantly affect operational costs.

Attached as Appendix B to this report is the current project schedule. Detailed design has started, and preparation of the procurement documentation for the scrubber and bioreactor covers is on schedule. Comox Valley Regional District staff will continue to work towards delivering the project on schedule, however due to uncertainties in the global supply chain and currency instability due to the COVID-19 pandemic, project delays may occur.

Staff will provide updates to the Comox Valley Sewage Commission, and the local community on any anticipated schedule delays as the project proceeds and the impacts of the COVID-19 pandemic become clearer.

Prepared by:	Concurrence:	Concurrence:	Concurrence:
Z. Berkey	***C. Gore***	***K. La Rose***	***M. Rutten***
Zoe Berkey, EIT Engineering Analyst	Charlie Gore, P.Eng Manager of Capital Projects	Kris La Rose, P.Eng Senior Manager of Water/Wastewater Services	Marc Rutten, P.Eng General Manager of Engineering Services

Government Partners and Stakeholder Distribution (Upon Agenda Publication)

Curtis Road Residents Association	✔

Attachments: Appendix A – "CVRD Odour Control Options Costs, ISL, February 3, 2020"
Appendix B – "Odour Control Project Schedule"

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To:	**Comox Valley Regional District**	Date:	**February 3, 2020**
Attention:	**Zoe Berkey, EIT**	Project No.:	**32397**
Cc:			
Reference:	**CVRD Odour Control Options Cost - Final**		
From:	**Ashraf Rayyan, P.Eng.**		

1.0 Introduction

ISL Engineering and Land Services Ltd. (ISL) was retained by the Comox Valley Regional District (CVRD) to provide engineering consulting services for the Comox Valley Water Pollution Control Centre (CVWPCC) Bioreactors Odour Control Study. The scope of the study included identifying the total air volume from the existing and future facilities that needs to be treated for odour removal, and providing a cost estimate for the new odour control system.

ISL submitted the required draft report on October 2019 and CVRD requested ISL to analyze more Options and to provide more clarification to the submitted report.

2.0 Odour Control Options Description

RWDI performed a dispersion model analysis and recommended that the bioreactors odorous gases to be directed through chemical scrubber/activated carbon for treatment and the existing stack to be maintained at its current height (17.0 m height).

ISL investigated various technologies for treatment of the Odours gases, which include chemical scrubber, activated carbon, biological filters (biofilters) and ultraviolet (UV) radiation. The advantages and disadvantages of each technology are summarized in Table 1.0.

Table 1.0: Odour Control Technologies - Advantages and Disadvantages

Technology	Advantages	Disadvantages	Target Application
Chemical Scrubber (Existing System)	• High efficiency for H_2S and organics • High air flow capacity per unit footprint • Lower capital cost • Effective with odour spikes	• Chemical cost is proportional to odour concentration; however, at low odour concentrations, chemical consumption is mainly driven by the ambient CO_2 concentration more than by odourous gases concentrations • Complex chemical controls • Cost of maintenance	• High flow rates • Limited space areas • Moderate foul air concentration <50 ppm • High concentration of organic odours • High removal efficiency

Technology	Advantages	Disadvantages	Target Application
Activated Carbon	• Low capital cost • Treat H_2S and some organic odours • Moderate air flow capacity • Good response to odour spikes	• Limited H_2S and organic odour capacities • High operating cost because of the activated carbon media replacement, especially if it is used as the only standalone treatment • Limited capacity for some organic odours	• Low foul air levels (1 to 20 ppm) • Polishing stage after chemical scrubber or biofilter
Biofilter	• High efficiency for H_2S removal • Moderate air flow capacity • Low operating cost	• Requires long contact time (footage) compared with other technologies • High capital cost • Less responsive to sudden odour spikes • Treatment efficiency is reduced in cold months • Requires large footprint compared with other technologies • Efficiency depends on the health of microorganisms • The need to keep the biofilter moist at all times (100% humidity is typical) • 10 years of media life as compared to 20 years on chemical scrubber	• High H_2S concentrations >50 ppm • Pre-treatment of H_2S prior to chemical scrubber or activated carbon • More effective in hot climates
UV System	• Smaller footprint • Low capital cost	• Proprietary technology, literature and publications appears to be limited • Limited installations for high capacity applications compared with other technologies • Pilot testing is highly recommended if chosen	• Mainly target small air flows, small systems (pump stations) • Area where internal air circulation is possible

Based on the advantages and disadvantages, two technologies were considered: chemical scrubber and activated carbon. A biofilter was not considered due to the cold weather considerations and the low concentrations of H_2S in the odorous air. At the same time, a UV system was not considered due to the limited installations of similar size systems within North America.

In the ISL draft report, two main Options were introduced to achieve the RWDI recommendation;

- **Option 1:** new chemical scrubber with activated carbon filter with a capacity of 30,600 m^3/hr to match the capacity of the existing activated carbon filter. This option will cover the plant requirements up to 2044.
- **Option 2:** new chemical scrubber with activated carbon filter with a capacity of 50,000 m^3/hr to cover the plant requirements up to 2066.

The estimated capital costs for Option 1 and Option 2 are $7.990 M and $8.452 M, respectively (including 40% engineering and construction contingencies). The differential cost between both options is not substantial and both options will provide significant odour reduction. As indicated in the report, Option 2 provides more value when compared with Option 1. Adding only $462 K (5.8% of project cost) will provide extra 20 years of system life and the system will have a sufficient capacity for all anticipated future facilities up to 2066. Therefore, Option 1 is not considered further in this memorandum.

The construction cost of both options were high and CVRD would like to analyze more options to reduce the associated capital cost. As a result, various sub-options of option 2 were developed. These options assume that odorous air are completely or partially treated according to the odour treatment process used for each option. Depending on the option(s) selected by CVRD, a dispersion model should be constructed to verify its viability and to determine the estimate odour levels at each receptor. Table 2.0 summarizes the description of each option and the treated air quantity for each Option.

Table 2.0: Treated Air Quality Options

Option Number	Description	Chemical Scrubber Capacity (m^3/hr)	Activated Carbon Capacity (m^3/hr)	Chemical Scrubber Capacity (m^3/hr)	Activated Carbon Capacity (m^3/hr)	Total Treated Air (chemical scrubber) m^3/hr	Total Treated Air (Activated Carbon) m^3/hr	Design Year	Notes
		Existing		New		Existing + New	Existing + New		
Option 2	Add new chemical scrubber 50,000 m^3/hr with new activated carbon filter 50,000 m^3/hr	30,600	30,600	50,000	50,000	80,600	80,600	2066	All odours gases are treated by chemical scrubber and activated carbon filter
Option 2A	Replace existing scrubber 30,600 m^3/hr with new chemical scrubber 80,600 m^3/hr, decommission existing scrubber and install new activated carbon filter 50,000 m^3/hr and expand the existing odor control building	30,600 (to be replaced)	30,600	80,600	50,000	80,600	80,600	2066	All odours gases are treated by chemical scrubber and activated carbon filter
Option 2B	Only replace existing scrubber 30,600 m^3/hr with new chemical scrubber 80,600 m^3/hr, decommission existing scrubber and expand the existing odor control building	30,600 (to be replaced)	30,600	80,600		80,600	30,600	2066	All odours gases are treated by chemical scrubber with a portion of air to be treated by activated carbon filter
Option 2C	Add only new chemical scrubber 50,000 m^3/hr	30,600	30,600	50,000		80,600	30,600	2066	All odours gases are treated by chemical scrubber with a portion of air to be treated by activated carbon filter
Option 2D	Add only new activated carbon filter 50,000 m^3/hr	30,600	30,600		50,000	30,600	80,600	2066	All odours gases are treated by activated carbon filter with a portion of air to be treated only by chemical scrubber

3.0 Options Cost Estimates

The cost estimates associated with each option/sub-option are included in Table 3.0. Figure 1.0 shows odour control piping. Capital cost breakdown are included in Appendix A

Table 3.0: Options Cost Estimates

Option Number	Description	Cost $	Engineering and contingencies (40%)	Total Cost (excluding GST)
		$	$	$
Option 2	Add new chemical scrubber 50,000 m^3/hr with new activated carbon filter 50,000 m^3/hr	$6,037,000	$2,415,000	$8,452,000
Option 2A	Replace existing scrubber 30,600 m^3/hr with new chemical scrubber 80,600 m^3/hr, decommission existing scrubber and install new activated carbon filter 50,000 m^3/hr and expand the existing odor control building	$6,284,000	$2,514,000	$8,798,000
Option 2B	Only replace existing scrubber 30,600 m^3/hr with new chemical scrubber 80,600 m^3/hr, decommission existing scrubber and expand the existing odor control building	$5,028,000	$2,012,000	$7,040,000
Option 2C	Add only new chemical scrubber 50,000 m^3/hr	$4,640,000	$1,856,000	$6,496,000
Option 2D	Add only new activated carbon filter 50,000 m^3/hr	$4,965,000	$1,986,000	$6,951,000

Notes: Total cost excludes GST

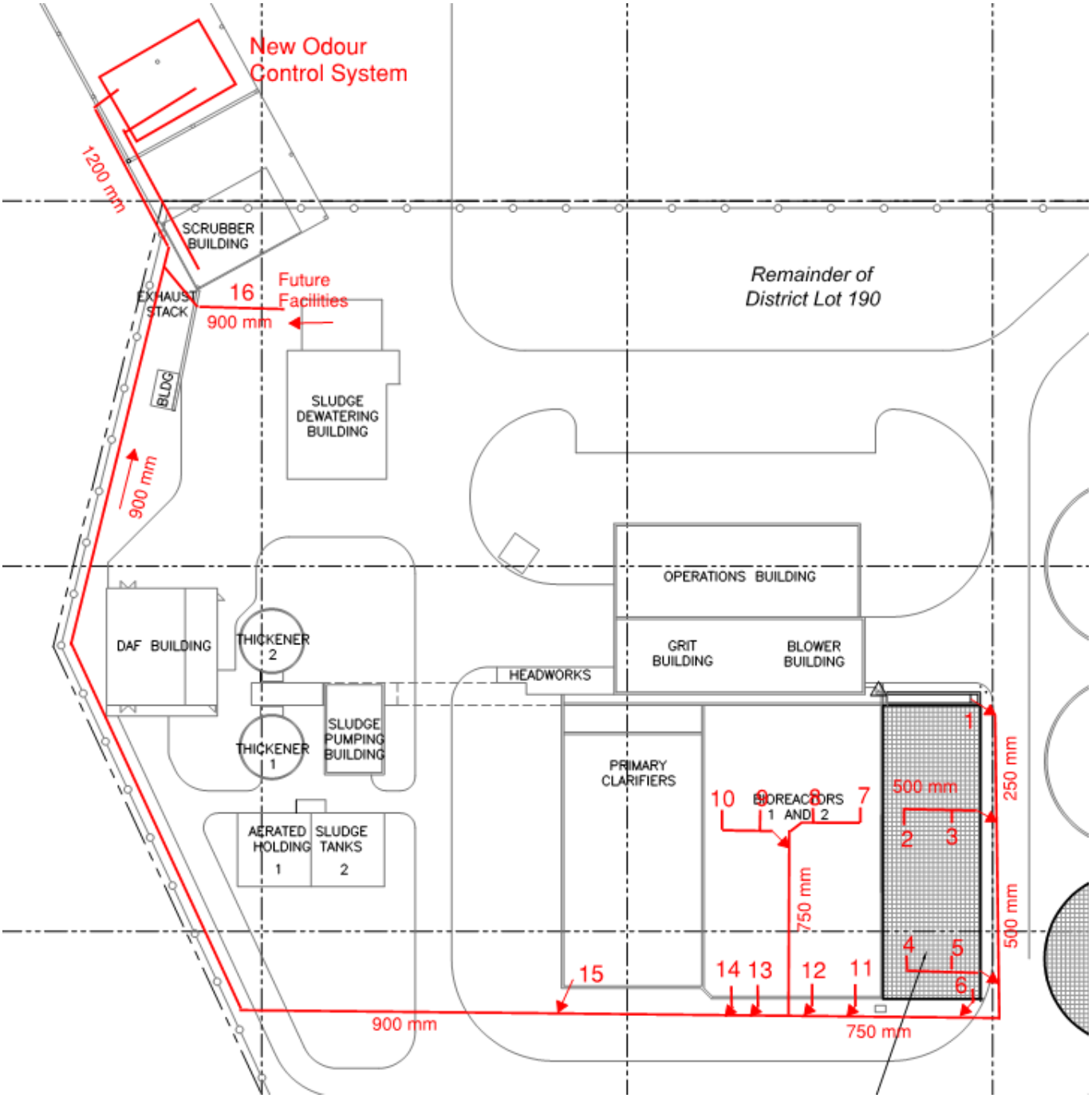


Figure 1.0: Odour Control Piping

4.0 Partial covering of bioreactors

RWDI conducted odour olfactory test for two bioreactors (September 2019), with samples taken from inlet, mid, and end of each bioreactor. Table 4.0 shows the results

Table 4.0: Olfactory Test Results (September 2019)

Location	Odour Threshold (OU)
Bioreactor Test 1 - Out	108
Bioreactor Test 2 - mid	198
Bioreactor Test 3 - in	1892
Bioreactor Test 4 - Out	181
Bioreactor Test 5 - mid	236
Bioreactor Test 6 - in	2918

Notes: Odour units (OU) are based on the required dilution for 50 % of the population to be able perceive an odour. This does assume that the population all have a normal range of sensitivity to odour.

From table 4.0, it is clearly that the measured odour at the inlet of the bioreactor is high compared with the odour levels at the mid and out of the bioreactor. Partial covering of bioreactors combined with epoxy coating of only half of bioreactors will provide a cost saving of $1.19M (including 40% engineering and contingencies). Subsequently, RWDI conducted odour olfactory test for three bioreactors (December 2019). Table 5.0 shows the results

Table 5.0: Olfactory Test Results (December 2019)

Location	Odour Threshold (OU)
Bio A - Out	335
Bio A - mid	741
Bio A - in	679
Bio B - Out	303
Bio B - mid	961
Bio B - in	961
Bio C - Out	403
Bio C - mid	881
Bio C - in	1048

Notes: Odour units (OU) are based on the required dilution for 50 % of the population to be able perceive an odour. This does assume that the population all have a normal range of sensitivity to odour.

Based on Table 4.0 (September 2019) results, partial covering of bioreactors was investigated. However, due to the December samples (Table 5.0) which show higher readings at the mid and out of the bioreactors, partial covering of the bioreactors may lead to higher odour levels at the receptor locations. At the same time, measurements were taken in December (winter month) and these readings can be higher during summer months. Normally, odours emissions increases with temperature during summer months.

At the same time, CVRD is preparing its Liquid Waste Management Plan. CVRD may choose to treat the wastewater for ammonia removal. Modifying the existing bioreactors for ammonia removal may require adding an anoxic zone and expanding the size of each bioreactor, this may increase the odour emissions from each bioreactor. Therefore, due to the uncertainty about the anticipated emissions during summer months and the future plans to expand the bioreactors, investigating of partial covering of the bioreactors was not pursued and installing full covers for each bioreactor is required.

5.0 Odour Control System Location

All described options/sub-options assume that the odour control system will be installed nearby the existing odour control system which is close to the discharge stack. This location is preferred because of the following reasons:

- Odour control system is centralized at one location within the treatment plant
- The existing treatment plant is planned to be expanded. The location of the expansion will be in close proximity to the existing odour control system.
- The chemical scrubber is comprised of large diameter vessel, fan, recirculation pumps, chemical storage tanks, chemical dosing pumps and electrical controls. All equipment needs to be installed indoor with exception of the scrubber vessel, which can be installed outdoor with appropriate engineering controls such as sump insulation and immersion heater for freeze protection during winter months. In addition, all outdoor chemical pipes will need to insulated and heat traced.

6.0 Options Operational Cost

Estimated operating costs were developed for all the options. The assumptions used for calculating the operating costs are included in Appendix A. Table 6.0 summarizes the Operational cost and ranks each Option on scale of 1 - 10, score of 10 represents the highest operating costs

Table 6.0: Estimated Options Operational Cost

Option Number	Description	Yearly Operating Costs	Score
Option 2	Add new chemical scrubber 50,000 m^3/hr with new activated carbon filter 50,000 m^3/hr	$404,000	10.0
Option 2A	Replace existing scrubber 30,600 m^3/hr with new chemical scrubber 80,600 m^3/hr, decommission existing scrubber and install new activated carbon filter 50,000 m^3/hr and expand the existing odor control building	$389,000	9.6
Option 2B	Only replace existing scrubber 30,600 m^3/hr with new chemical scrubber 80,600 m^3/hr, decommission existing scrubber and expand the existing odor control building	$210,000	5.2
Option 2C	Add only new chemical scrubber 50,000 m^3/hr	$213,000	5.3
Option 2D	Add only new activated carbon filter 50,000 m^3/hr	$388,000	9.6

7.0 Options Net Present Value

To provide a complete financial analysis, ISL undertook a 20-year net present value analysis using annual discount rate of 2%

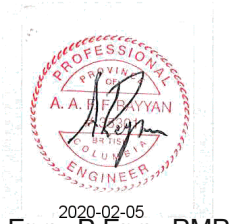
Table 7.0: Net Present Value Analysis

Description	OPTION 2	OPTION 2A	OPTION 2B	OPTION 2C	OPTION 2D
Total capital cost	$8,452,000	$8,798,000	$7,040,000	$6,496,000	$6,951,000
Total annual maintenance cost	$404,000	$389,000	$210,000	$213,000	$388,000
Equipment life cycle (yrs.)	20	20	20	20	20
Discount rate (Annual %)	2%	2%	2%	2%	2%
Net present value (Rounded)	$ 15,058,000	$ 15,159,000	$10,474,000	$9,979,000	$13,295,000

8.0 Closure

Please do not hesitate to contact the undersigned should there be any questions or should additional information be required.

SMALL FORMAT



2020-02-05

Sincerely,

Ashraf Rayyan, M.Eng., P.Eng., PMP
Manager, Water and Wastewater

Attachments:

1. Appendix A Options Capital Cost Breakdown
   Operational Cost estimate

Appendix A

1.0 Estimated Capital Cost

The estimated capital costs in Table A.1 are considered to be at a conceptual level (Class D). A contingency of 40% is included in the cost estimates for engineering and construction. The cost estimates do not include applicable taxes.

Table A.1: Options Capital Cost Breakdown

Item	Description	Option 2	Option 2A	Option 2B	Option 2C	Option 2D
1	General requirement includes (overhead, indirect cost, contractor profit, mobilization and demobilization and temporary work)	$1,320,000	$1,257,000	$1,006,000	$928,000	$993,000
2	Design and supply of bioreactor covers	$700,000	$700,000	$700,000	$700,000	$700,000
3	Install of bioreactor covers	$200,000	$200,000	$200,000	$200,000	$200,000
4	Design, supply, and install of odour control ducting					
	Diameter 250 mm (45 m)	$12,000	$12,000	$12,000	$12,000	$12,000
	Diameter 400 mm (116 m)	$67,000	$67,000	$67,000	$67,000	$67,000
	Diameter 500 mm (53 m)	$44,000	$44,000	$44,000	$44,000	$44,000
	Diameter 750 mm (58 m)	$97,000	$97,000	$97,000	$97,000	$97,000
	Diameter 900 mm (223 m)	$520,000	$520,000	$520,000	$520,000	$520,000
	Diameter 1200 mm (60 m)	$227,000	$227,000	$227,000	$227,000	$227,000
5	Modifications and installation of bioreactors influent and effluent channels covers	$120,000	$120,000	$120,000	$120,000	$120,000
6	Bioreactors epoxy coating	$800,000	$800,000	$800,000	$800,000	$800,000
7	Design, supply and install of chemical scrubber	$645,000	$855,000	$855,000	$645,000	
8	Pipes/equipment modifications to accommodate new chemical scrubber	$100,000	$40,000	$40,000	$100,000	
9	Design, supply and install of AC	$1,005,000	$1,005,000			$1,005,000
10	Expand new building to accommodate new chemical scrubber		$120,000	$120,000		
11	Decommission existing scrubber		$40,000	$40,000		
12	Electrical	$180,000	$180,000	$180,000	$180,000	$180,000
	Subtotal	**$6,037,000**	**$6,284,000**	**$5,028,000**	**$4,640,000**	**$4,965,000**
	Engineering and contingencies (40%)	$2,415,000	$2,514,000	$2,012,000	$1,856,000	$1,986,000
	Total (excluding GST)	**$8,452,000**	**$8,798,000**	**$7,040,000**	**$6,496,000**	**$6,951,000**

2.0 Estimated Operational Cost

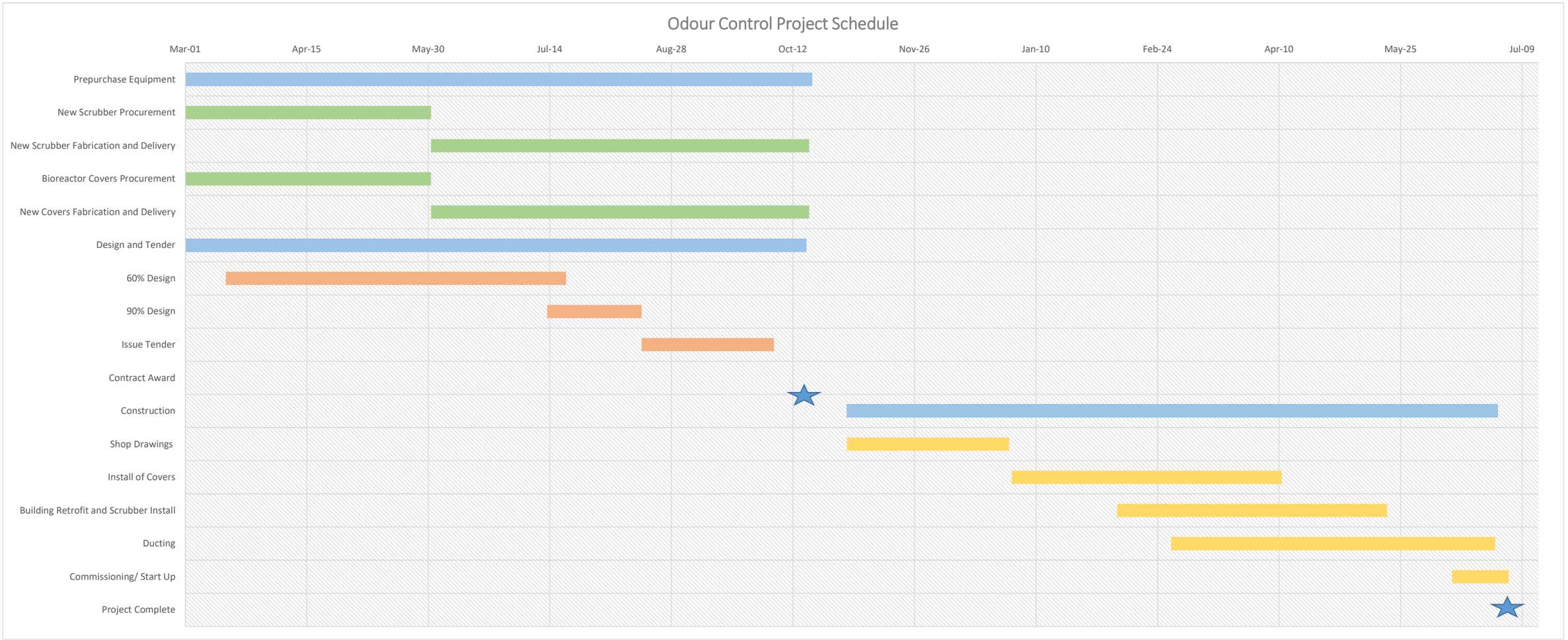
Operating costs were developed for all the options. The assumptions used for calculating the operating costs are as follows:

- Treated airflow of 50,000 m^3/hour (29,429 cfm) for 24/7 treatment.
- Operating costs does not include existing operating costs for the existing chemical scrubber and activated carbon filter. Operating costs represents the associated cost of treating the additional airflow rate.
- Option 2B and 2C require replacing the existing chemical scrubber with higher capacity scrubber (i.e.80,600 m^3/hr). However, the operating costs are based on the additional flow 50,000 m^3/hr, to provide equal evaluation criteria for all options.
- Chemical scrubber maintenance man-hours for Option 2B and 2C are considered zero, due to the fact that the existing scrubber will be replaced with a new scrubber. The required effort for maintaining the existing scrubber is equal to the required effort to maintain the replaced scrubber, and required effort is already included in the existing scrubber operational costs which is not covered here.
- Average inlet level of 2 ppm of H_2S and 2 ppm of organic compounds for odour treatment.
- Chemical scrubber's odour removal efficiency is 60% on H_2S and organic compounds.
- Activated carbon filter removal efficiency is 78.3% on H_2S and on organic compounds.
- Chemical scrubber and activated carbon filter combined efficiency is 87.1% on H_2S and on organic compounds
- Caustic soda cost = 0.25 $/lit
- Sodium hypochlorite cost = 0.25 $/lit
- Water (potable) = $1/$m^3$
- Electricity = $0.1/kWh
- Labour cost = $40/hour
- Equipment life cycle = 20 years
- Carbon media = 3050 $/$m^3$
- Chemical scrubber media = 960 $/$m^3$

Table A.2 Estimated Operational Cost

Description	UNITS	OPTION 2		OPTION 2A		OPTION 2B	OPTION 2C	OPTION 2D
		Chemical Scrubber	Dual Bed Carbon Polisher	Chemical Scrubber	Dual Bed Carbon Polisher	Chemical Scrubber	Chemical Scrubber	Dual Bed Carbon Polisher
Additional Treated Air Flow Rate	m^3/hr	50,000	50,000	50,000	50,000	50,000	50,000	50,000
System operating power for the additional air flow	bhp	100	60	100	60	100	100	60
Power Cost for the Additional Air Flow		$65,350	$39,210	$65,350	$39,210	$65,350	$65,350	$39,210
25% Sodium Hydroxide usage	lit/30 days	35,794	n/a	35,794	n/a	35,794	35,794	n/a
Annual Sodium Hydroxide cost		$107,382	n/a	$107,382	n/a	$107,382	$107,382	n/a
12.5 Sodium Hypochlorite usage (gal/15 days)	lit/15 days	5809	n/a	5809	n/a	5809	5809	n/a
Annual 12.5% Sodium Hypochlorite cost		$34,855	n/a	$34,855	n/a	$34,855	$23,943	n/a
Media Life	yr	20	1.2	20	1.2	20	20	0.5
Media Volume	m^3	18	55.0	18	55.0	18	18	55.0
Average Annualized Media Cost		$865	$138,456	$865	$138,456	$865	$865	$346,141
Annual Water usage	m^3	594	0	594	0	594	594	0
Annual Water cost		$594	$-	$594	$-	$594	$594	$-
Maintenance Man-hours/Week	hr	7	1	0	1	0	7	1
Yearly labour maintenance cost@$40/hr		$14,560	$2,080	$-	$2,080	$-	$14,560	$2,080
Annual Maintenance cost/process unit (materials + labor)		$223,606	$179,746	$209,046	$179,746	$209,046	$212,693	$387,430
Total Annual Maintenance cost (materials + labor), round to 000		$404,000		$389,000		$210,000	$213,000	$388,000
Operating Cost Rank on Scale (1-10)		10.0		9.6		5.2	5.3	9.6

Appendix B


Odour Control Project Schedule
Mar-01
Apr-15
May-30
Jul-14
Aug-28
Oct-12
Nov-26
Jan-10
Feb-24
Apr-10
May-25
Jul-09
Prepurchase Equipment
New Scrubber Procurement
New Scrubber Fabrication and Delivery
Bioreactor Covers Procurement
New Covers Fabrication and Delivery
Design and Tender
60% Design
90% Design
Issue Tender
Contract Award
Construction
Shop Drawings
Install of Covers
Building Retrofit and Scrubber Install
Ducting
Commissioning/ Start Up
Project Complete